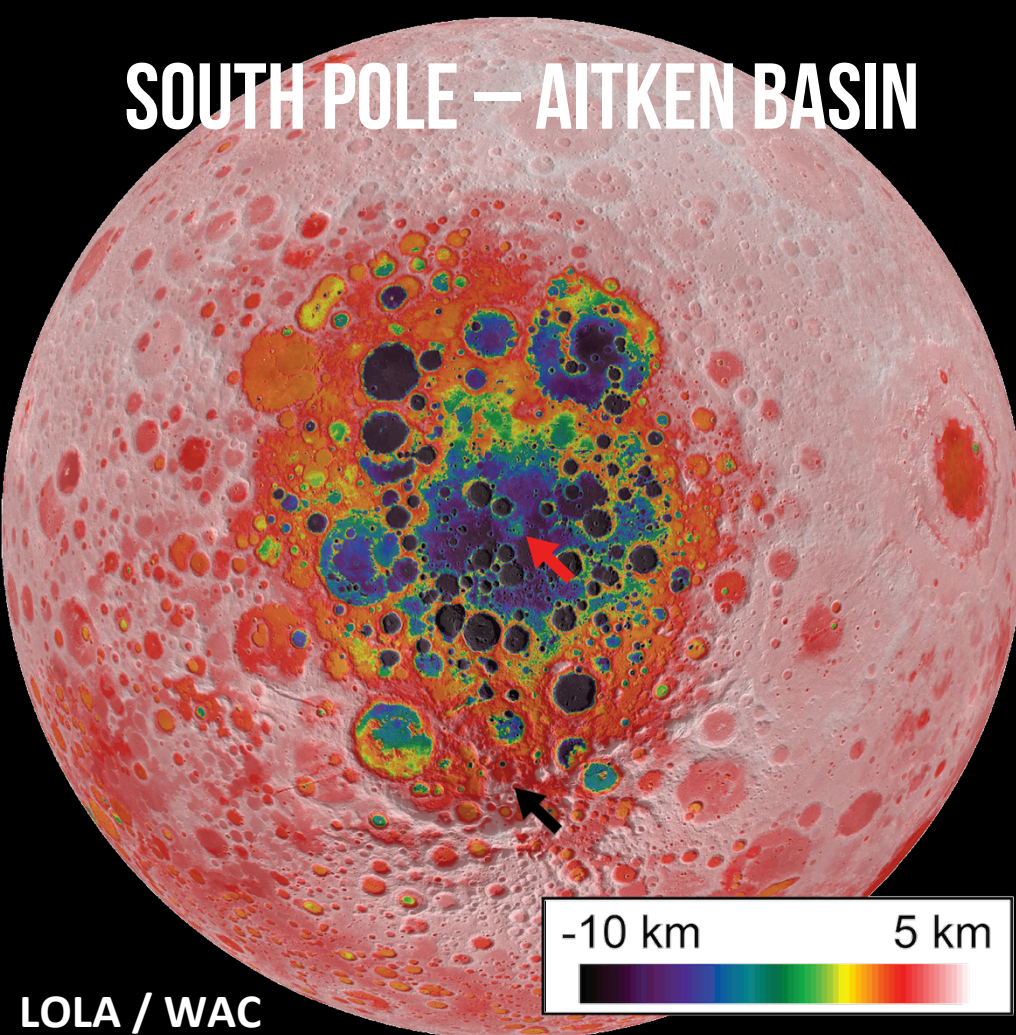


THE MAGMATIC EVOLUTION OF SPA: INSIGHTS FROM MAFIC MOUND

Daniel Moriarty
Carle Pieters
SSERVI ESF
July 22, 2015

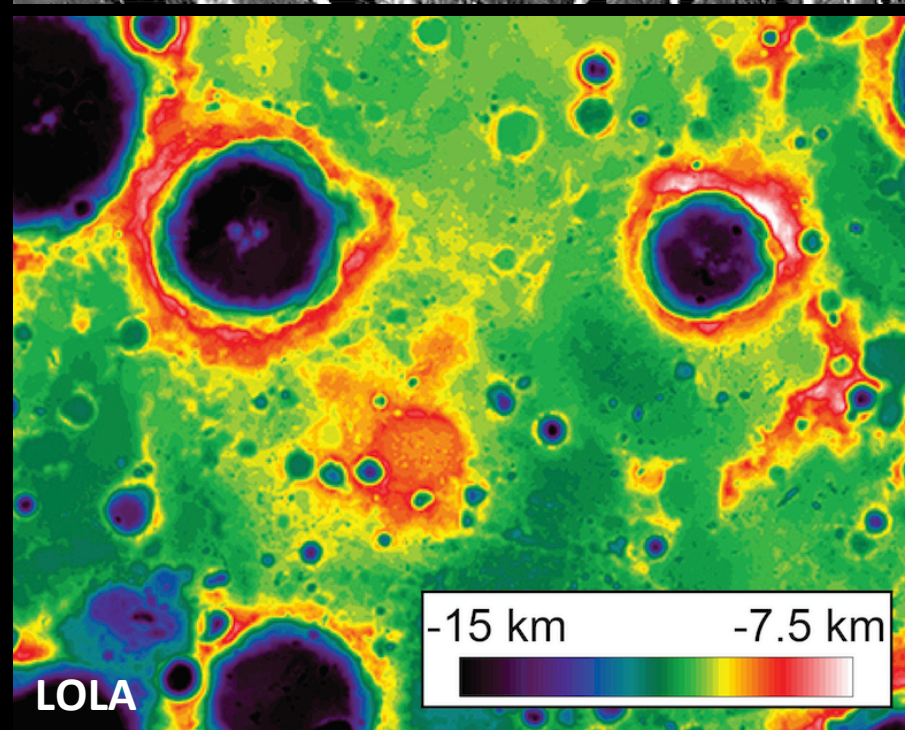
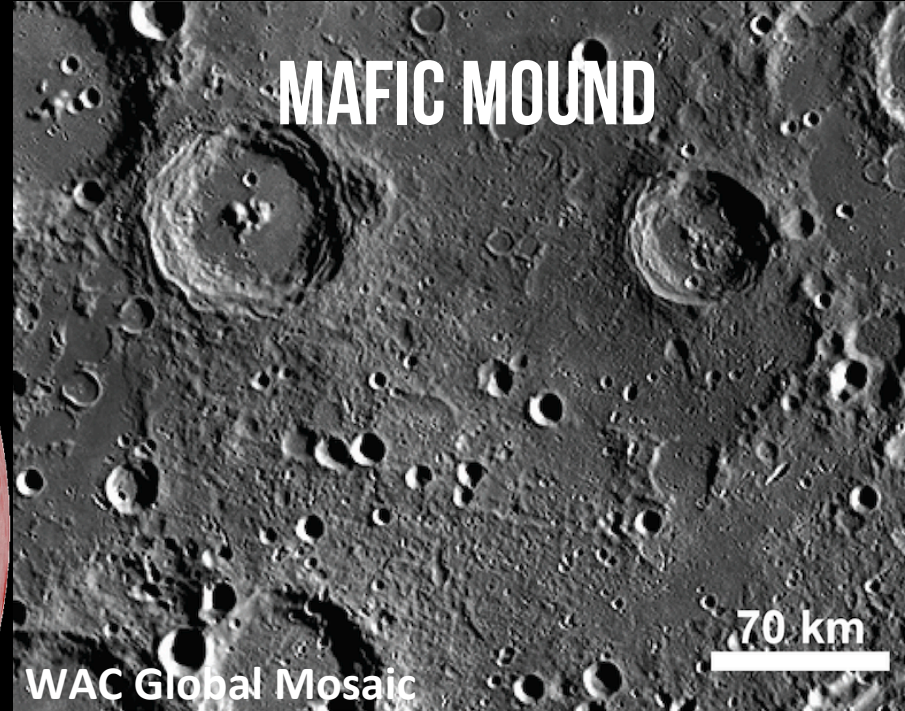
SOUTH POLE — AITKEN BASIN

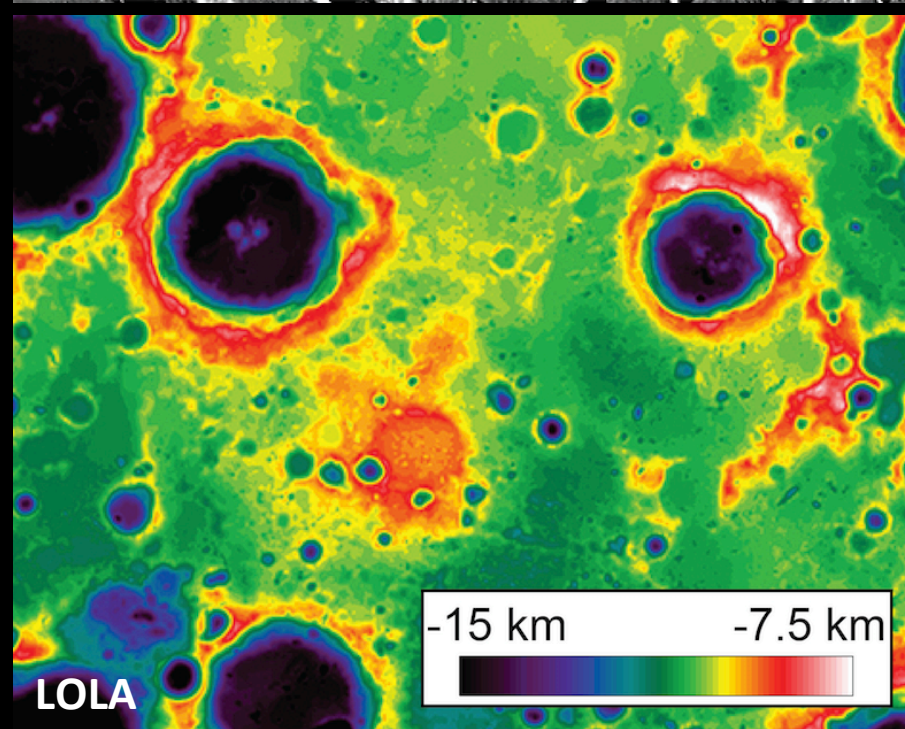
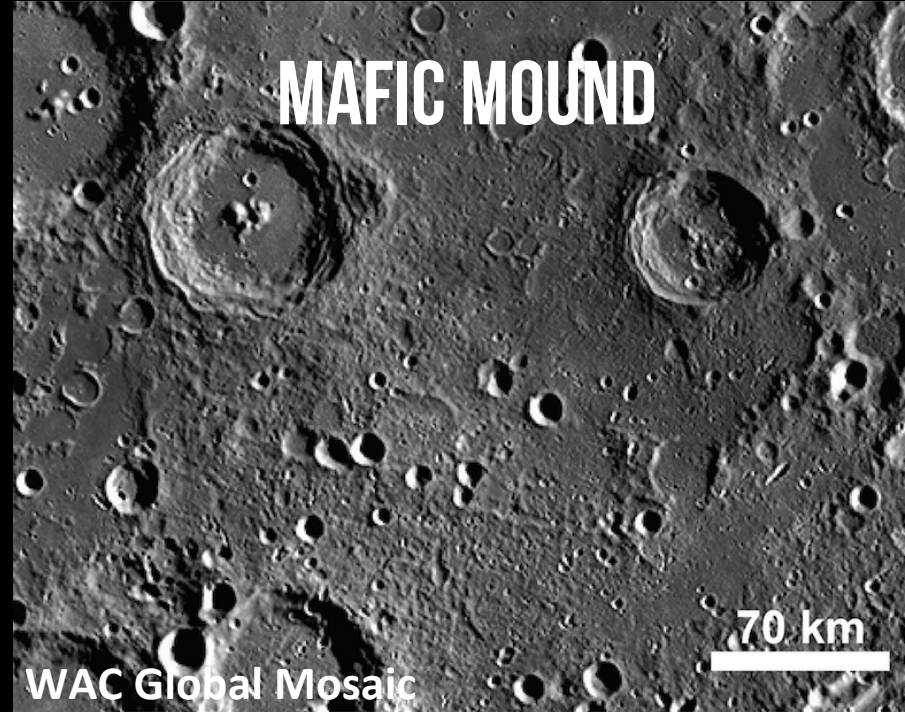
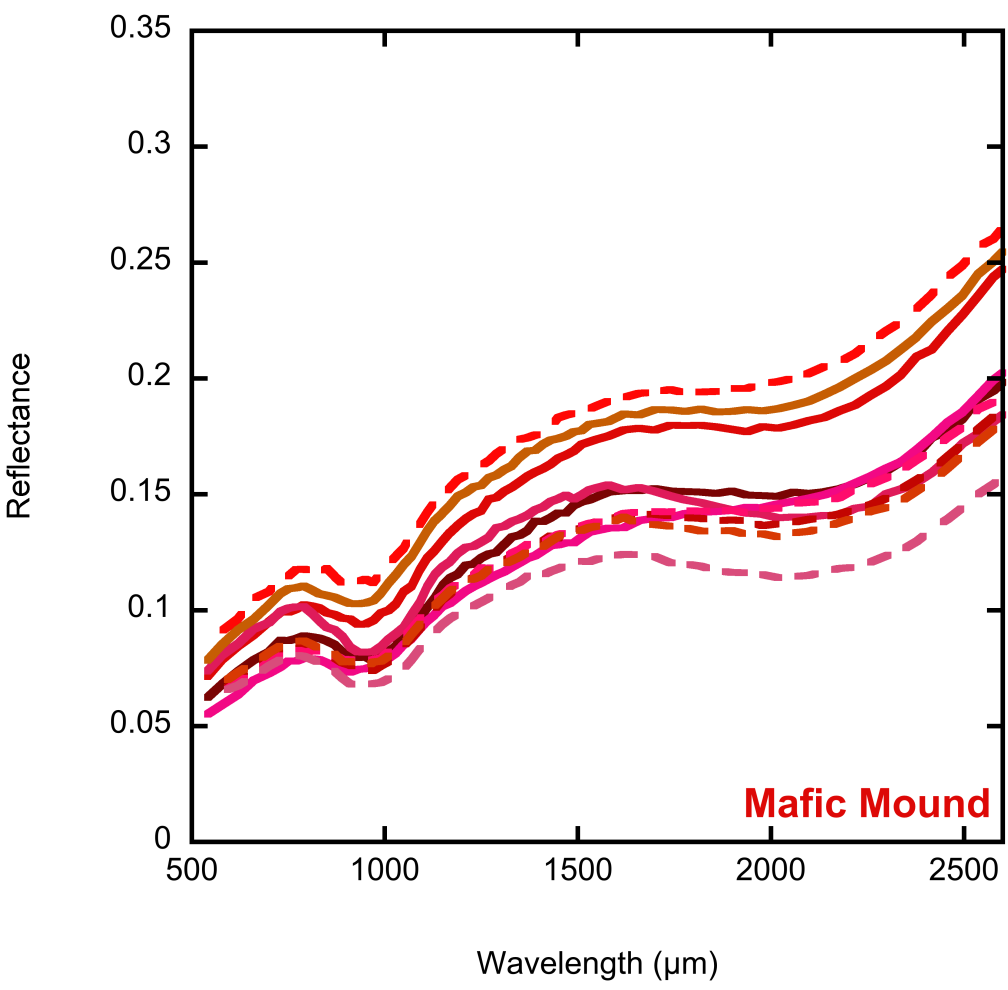


LOLA / WAC

Mafic Mound is an unusual positive-topography feature at the center of SPA.

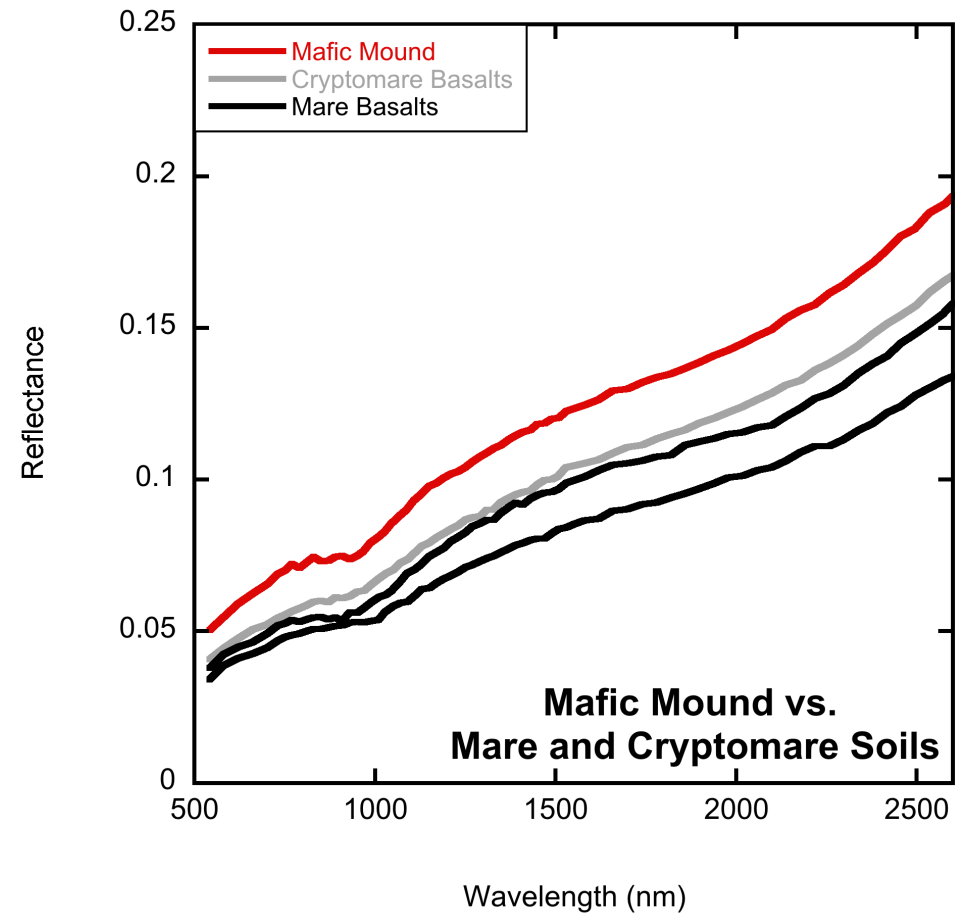
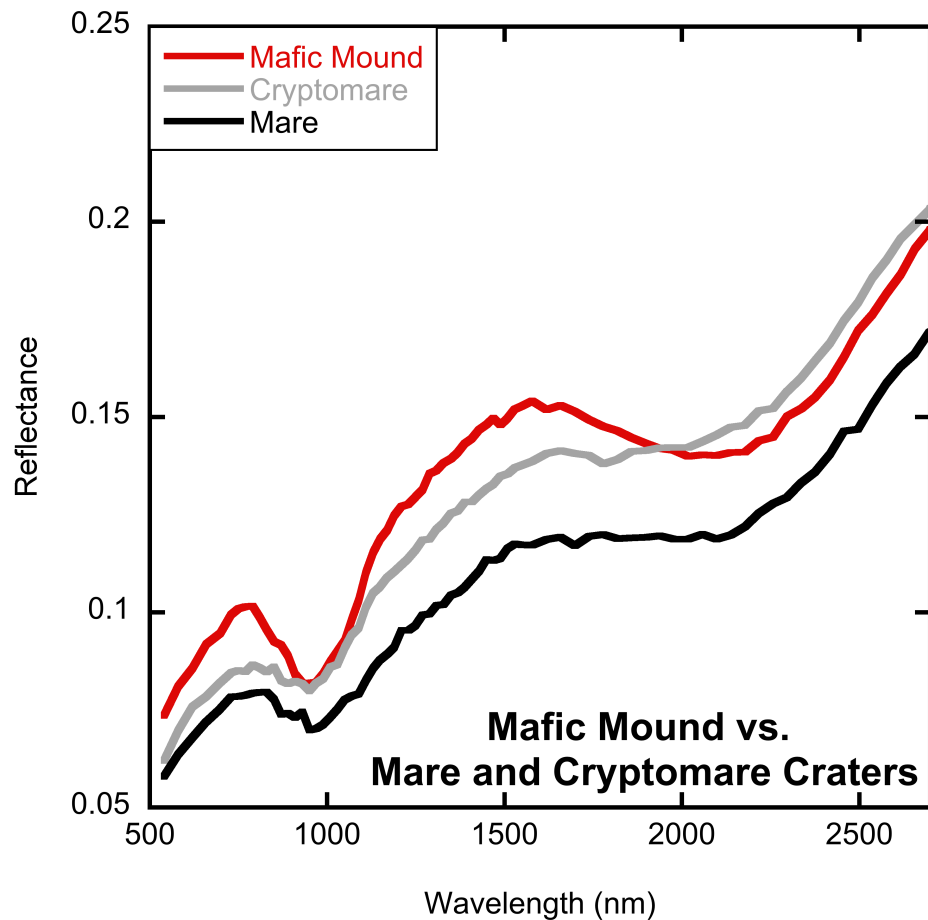
MAFIC MOUND



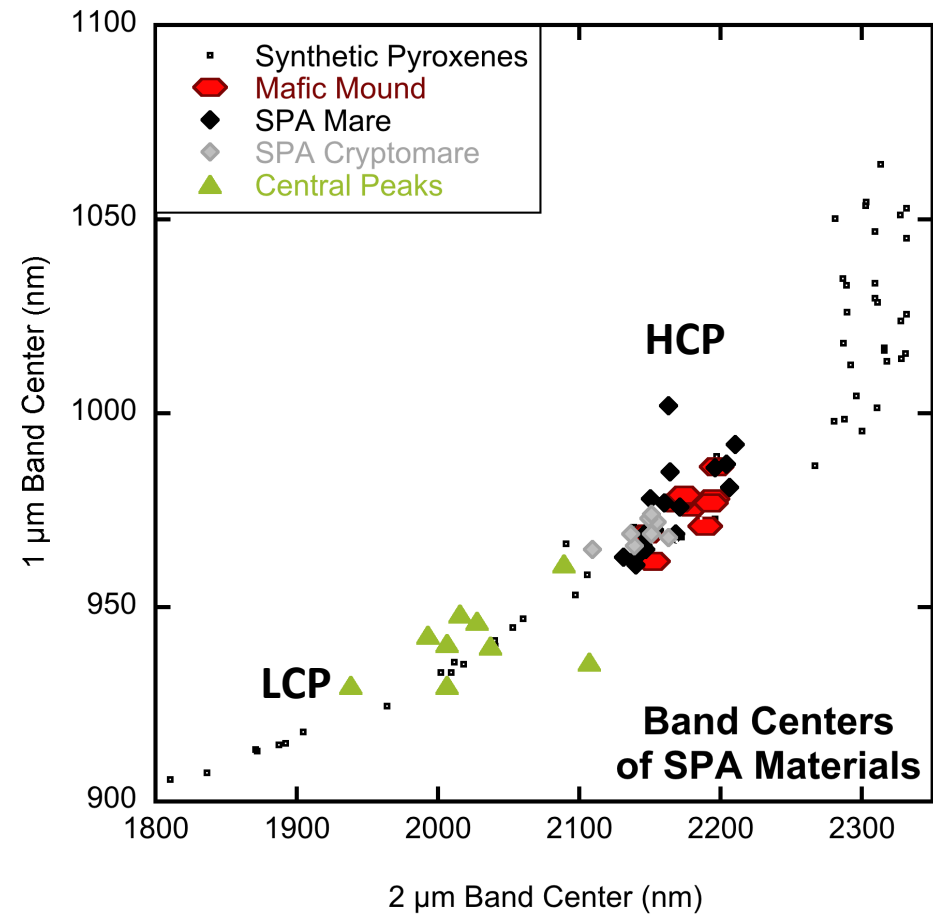
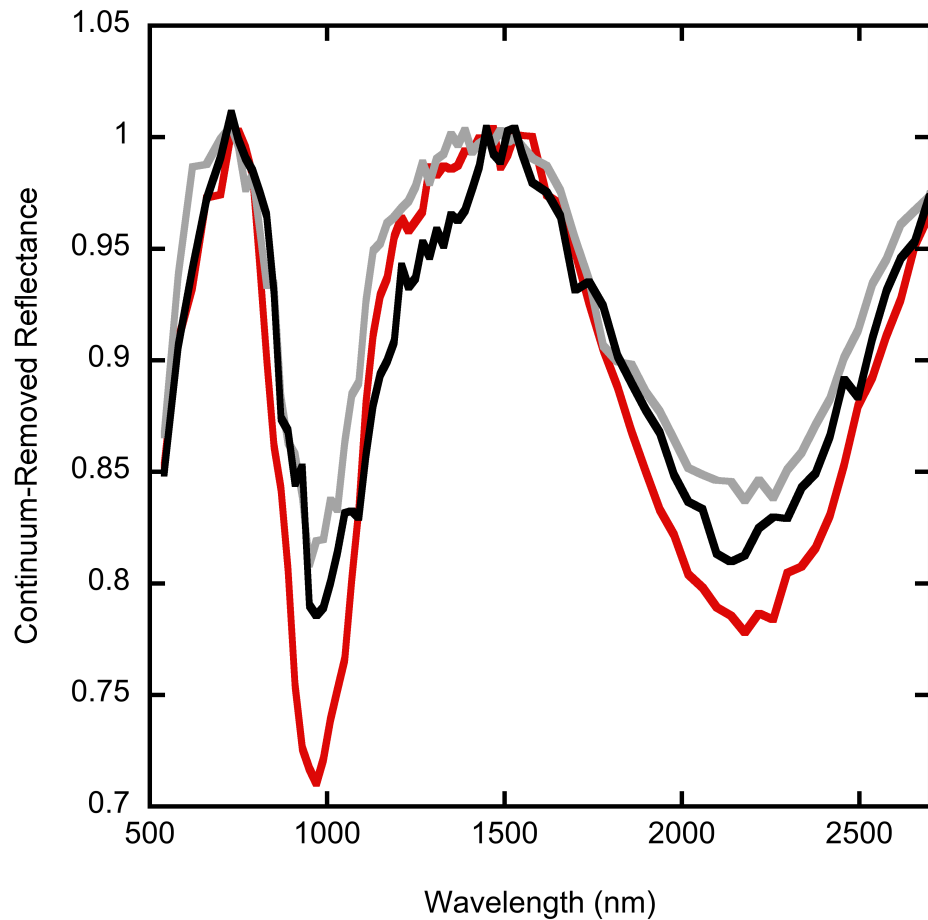


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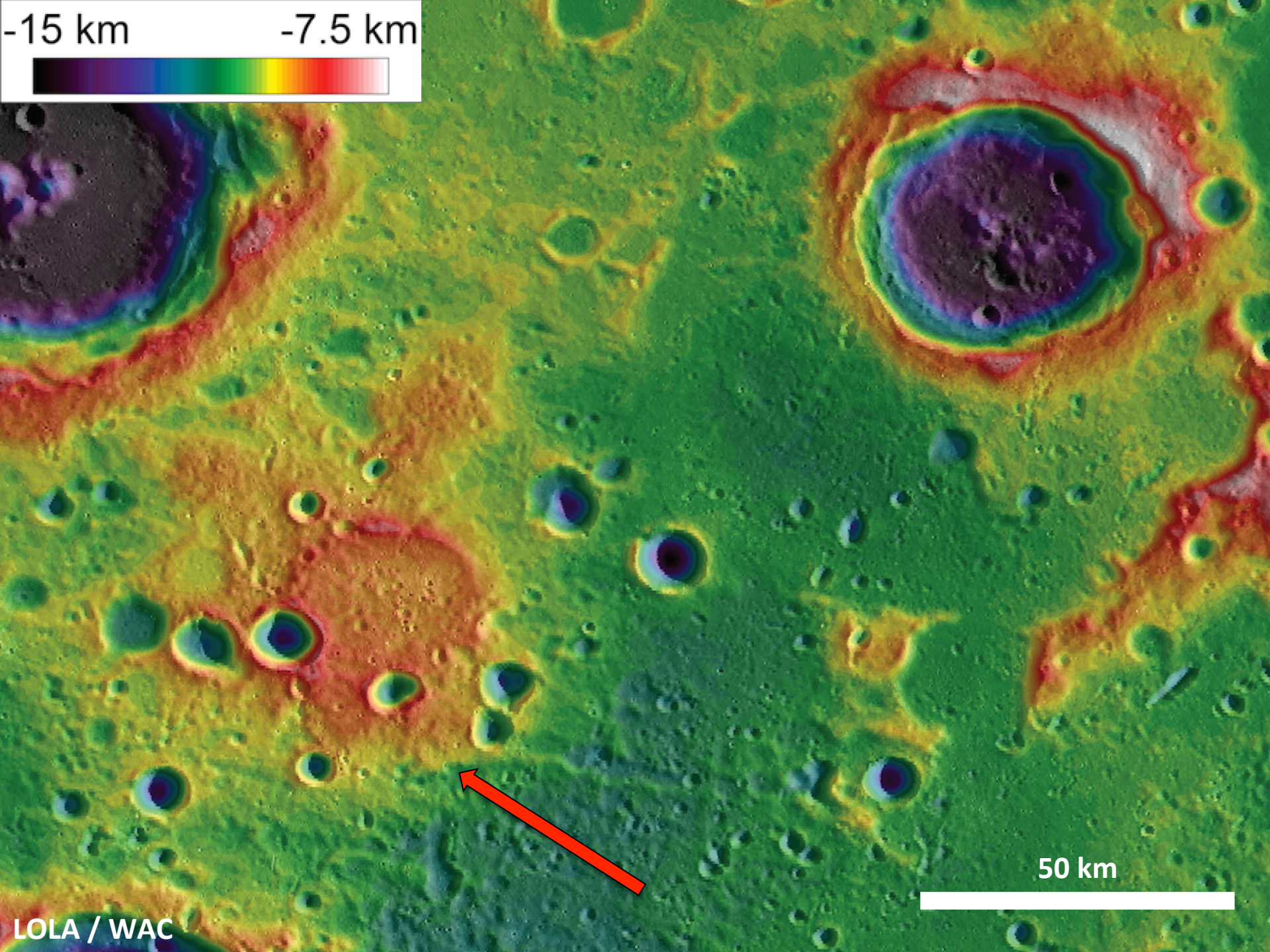
SPECTRA: MAFIC MOUND VS. MARE BASALTS



BAND CENTERS: MAFIC MOUND VS. MARE BASALTS



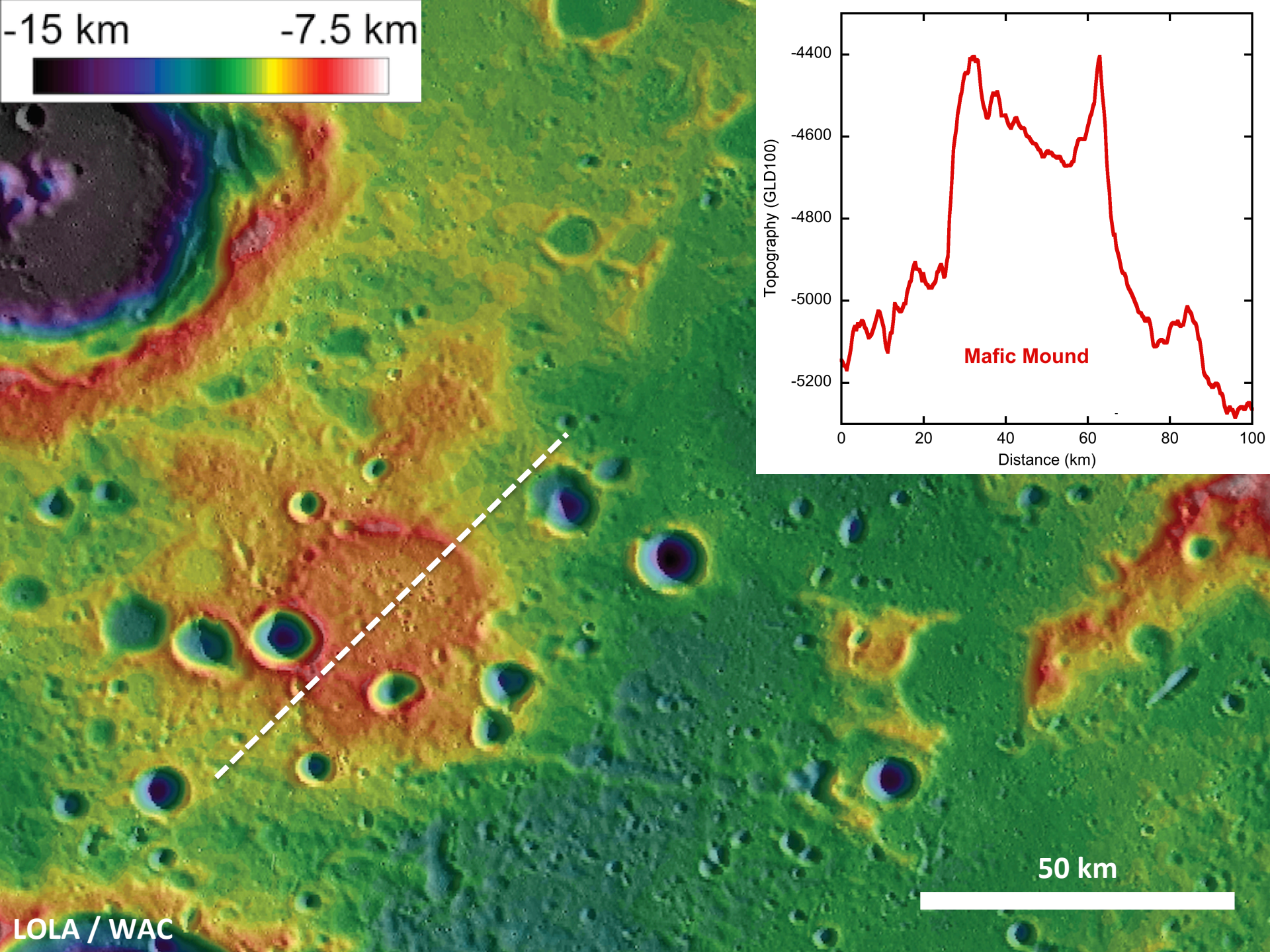
-15 km -7.5 km



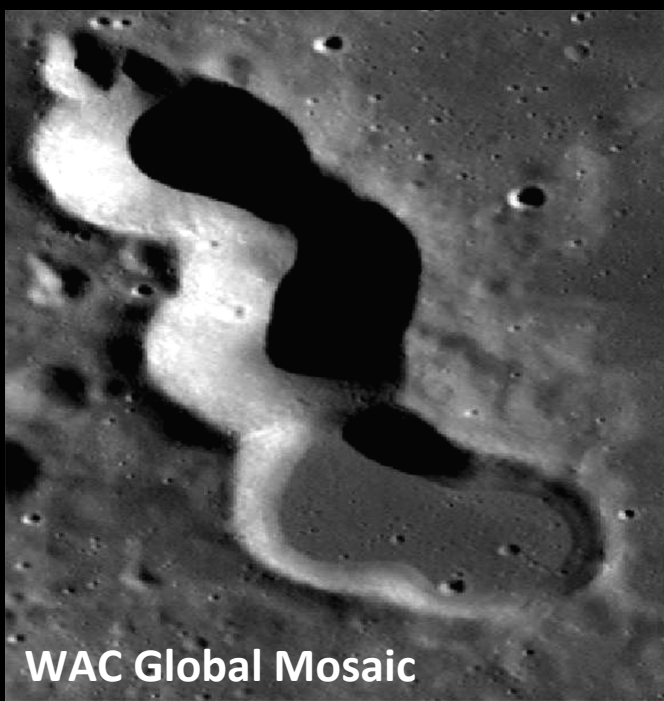
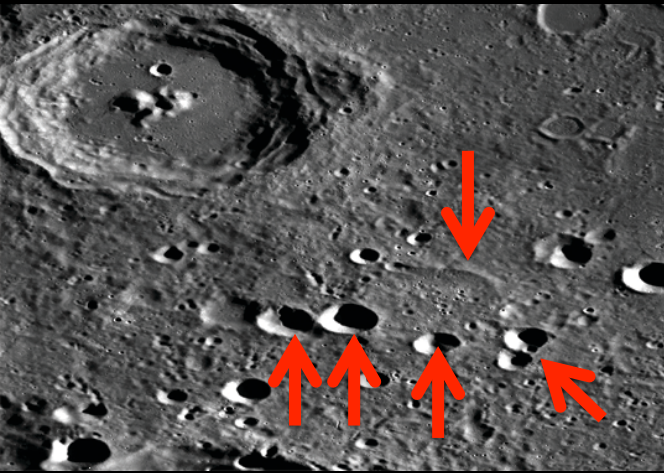
50 km

LOLA / WAC

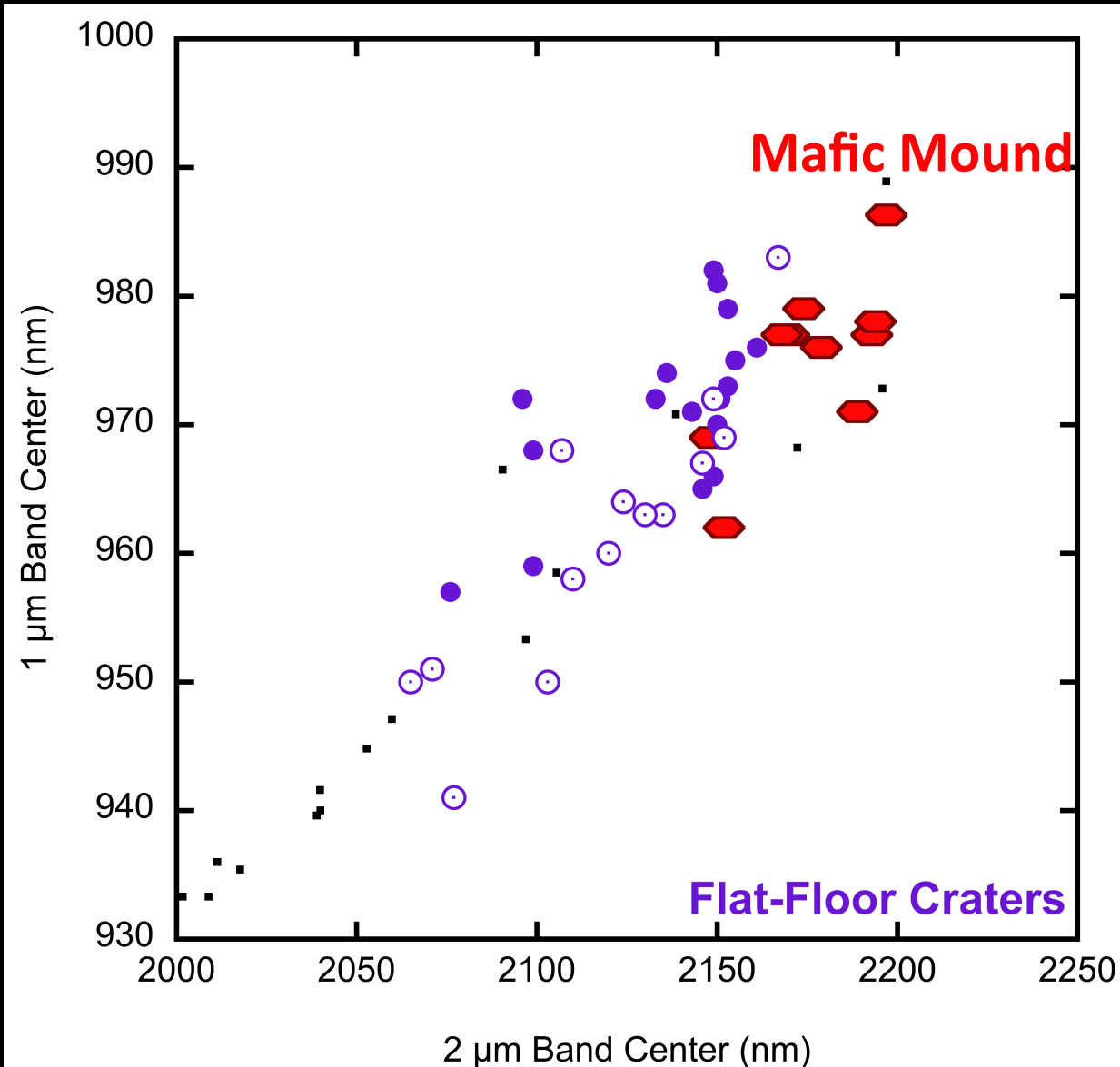
-15 km -7.5 km



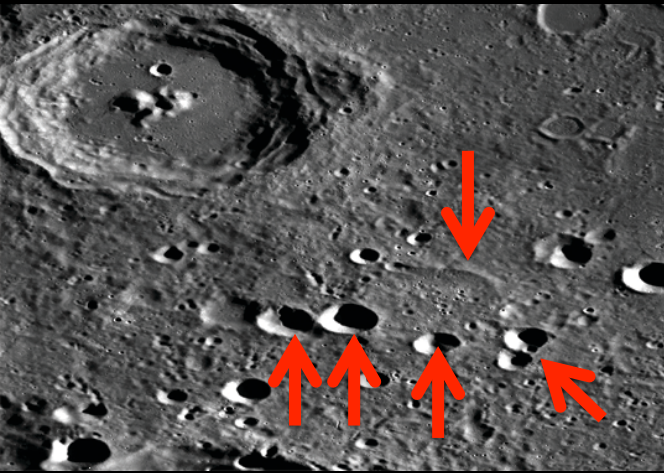
MAFIC MOUND VS. BASALT-FILLED IMPACT CRATERS



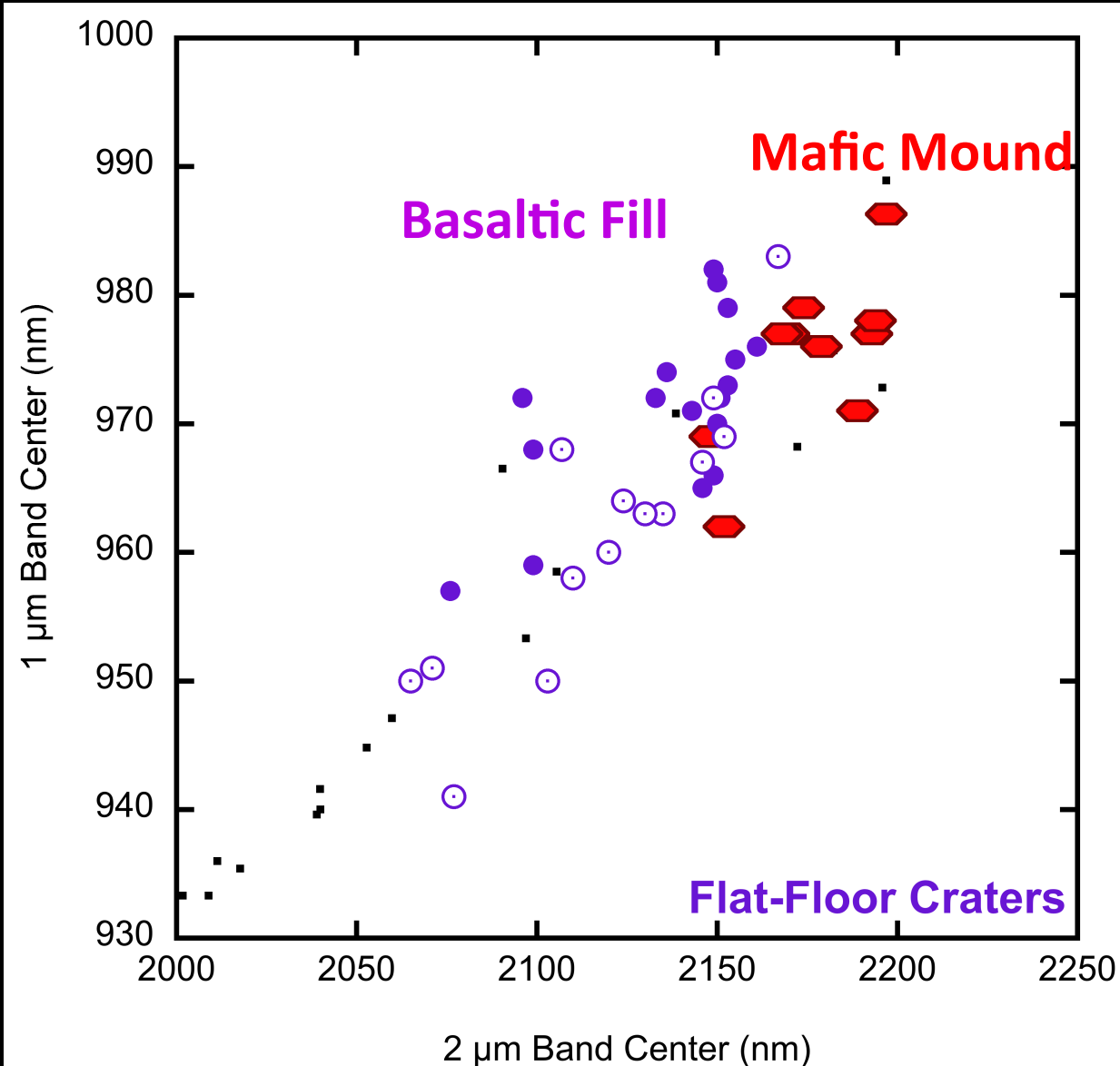
WAC Global Mosaic

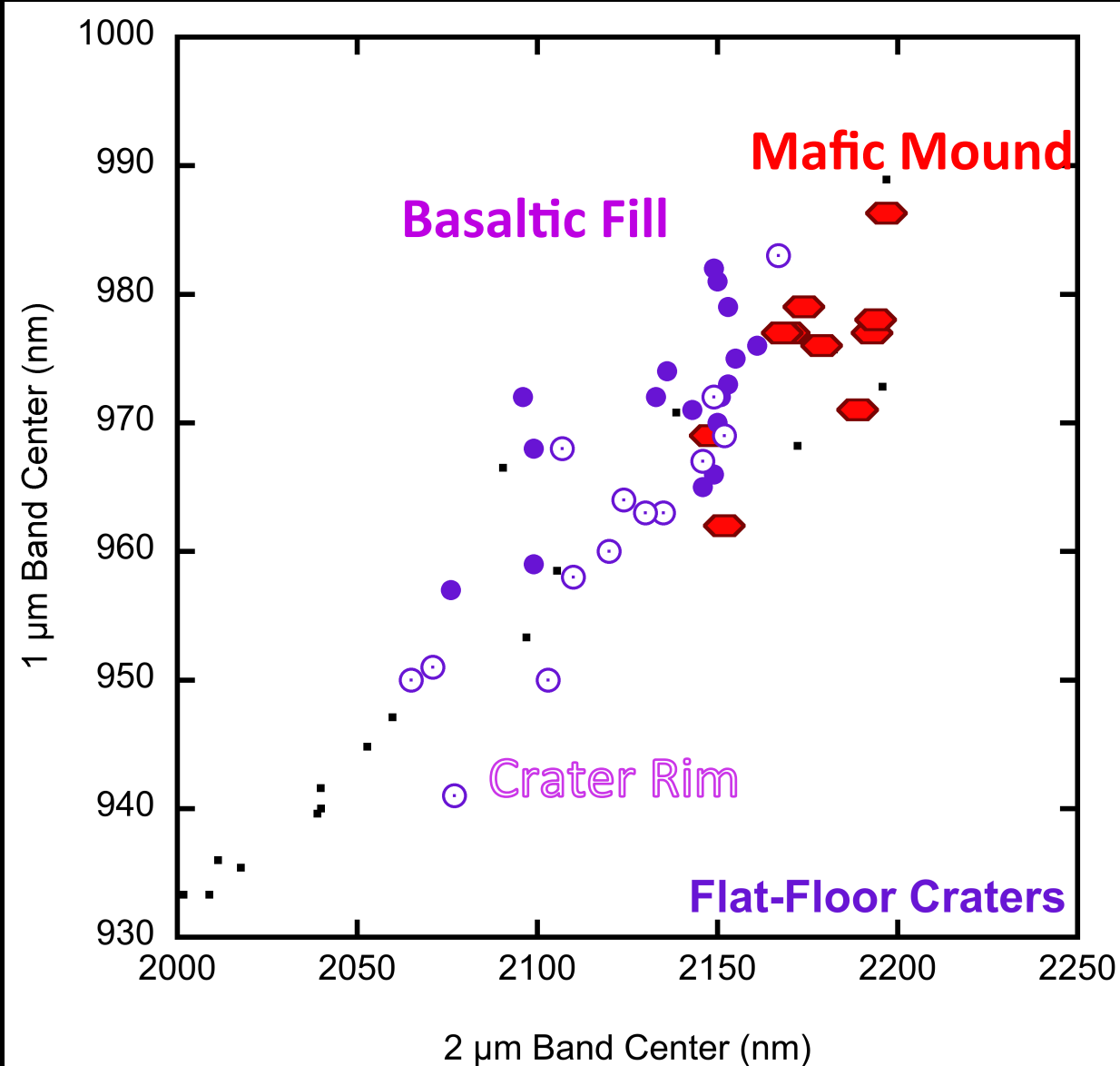
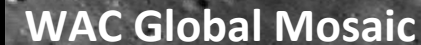


MAFIC MOUND VS. BASALT-FILLED IMPACT CRATERS

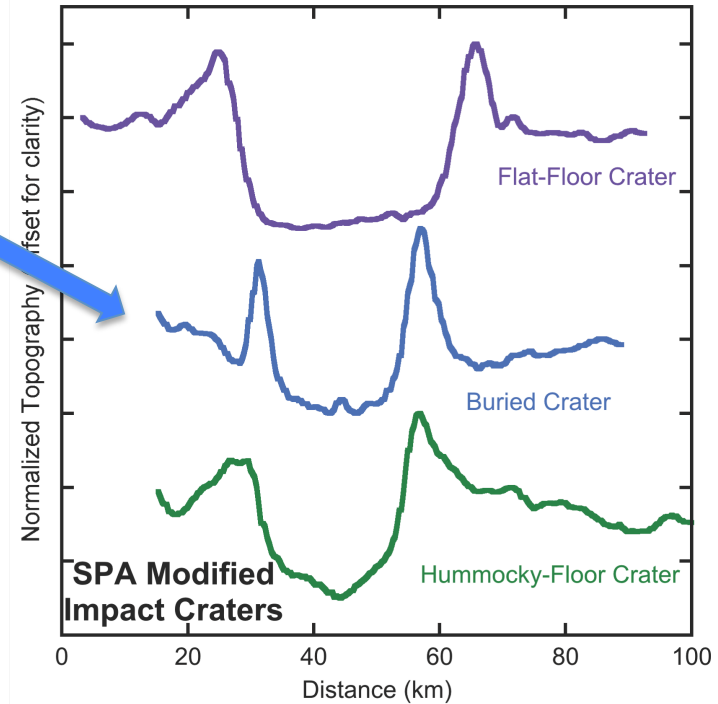
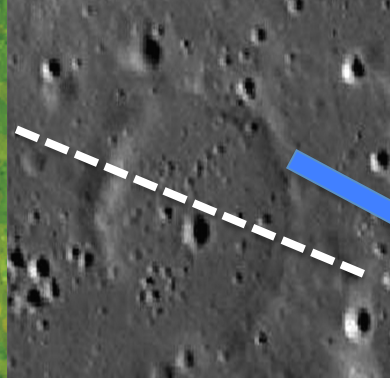
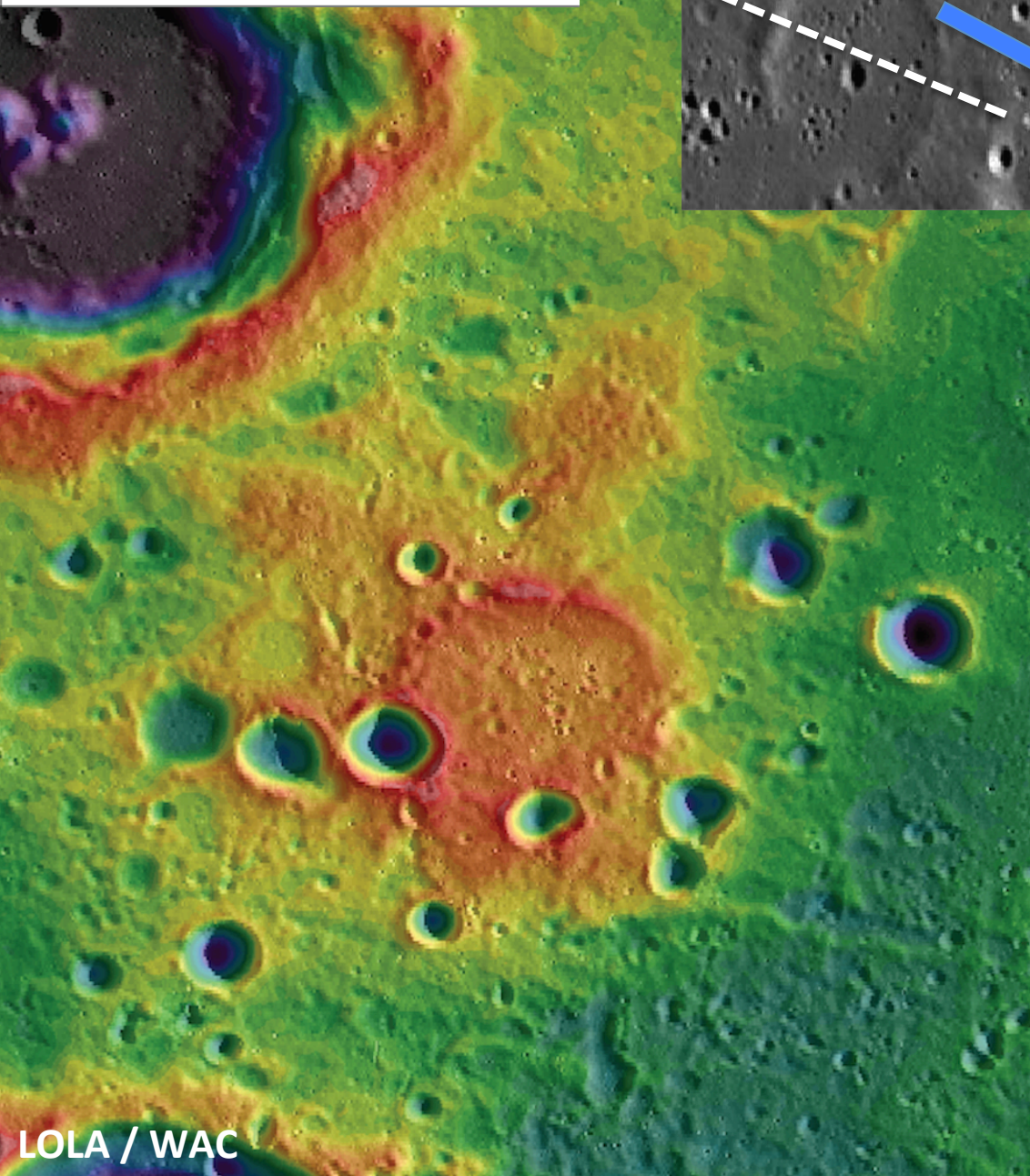


WAC Global Mosaic





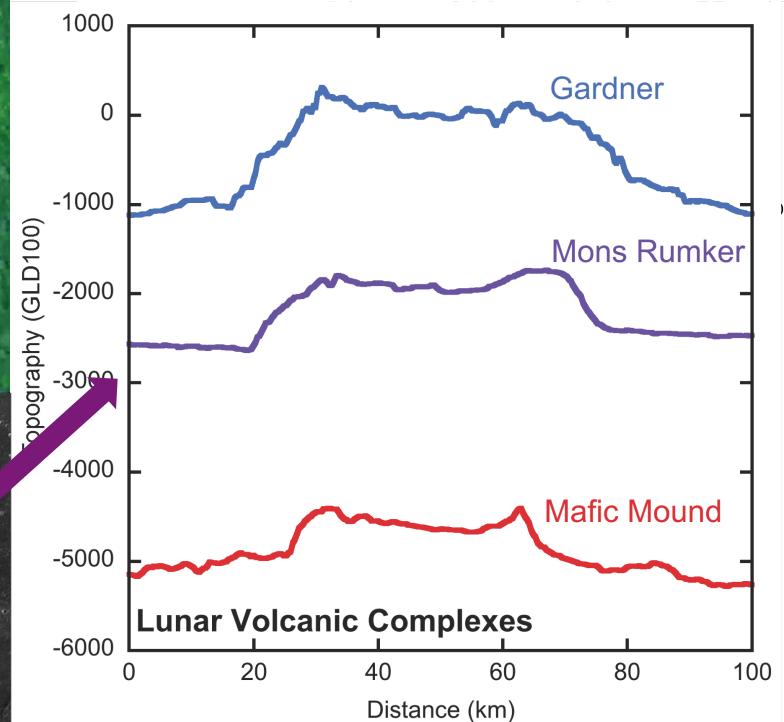
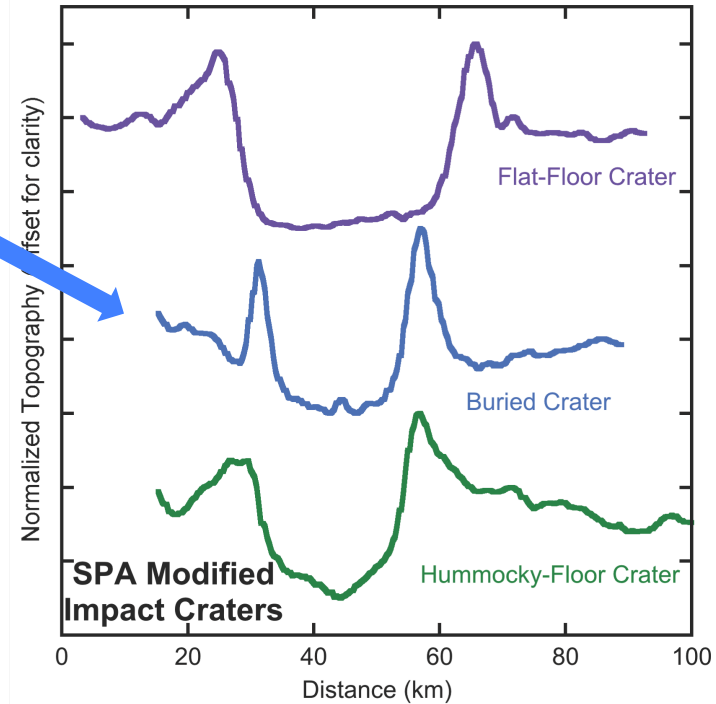
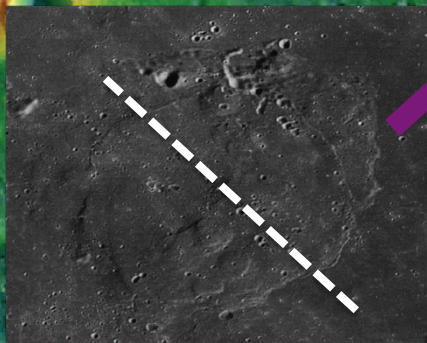
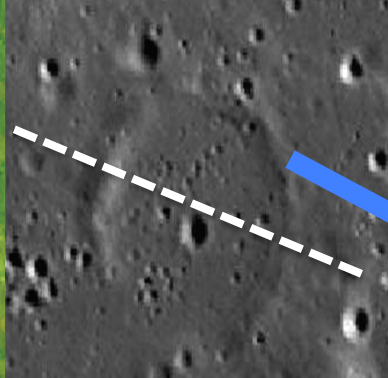
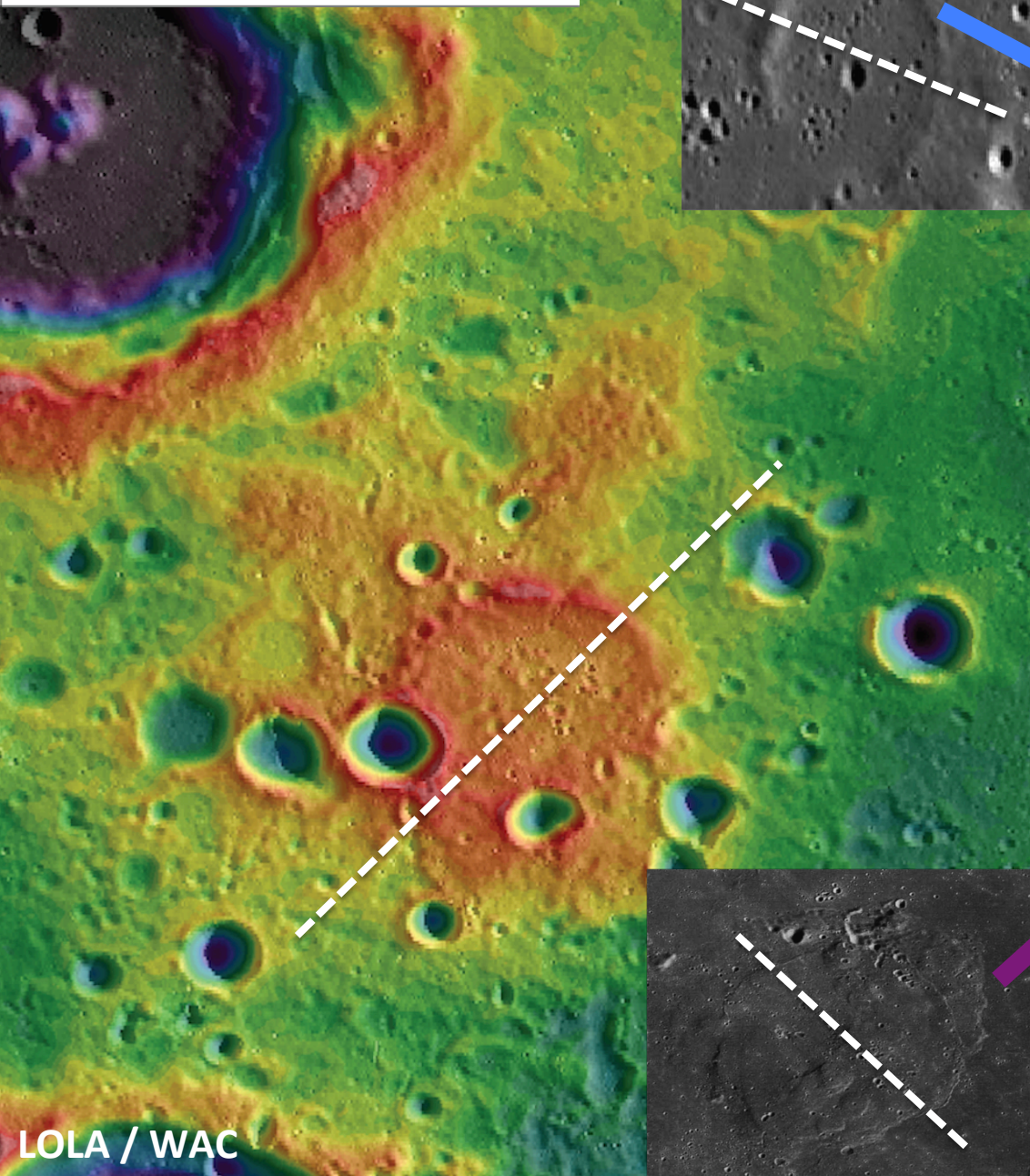
-15 km -7.5 km



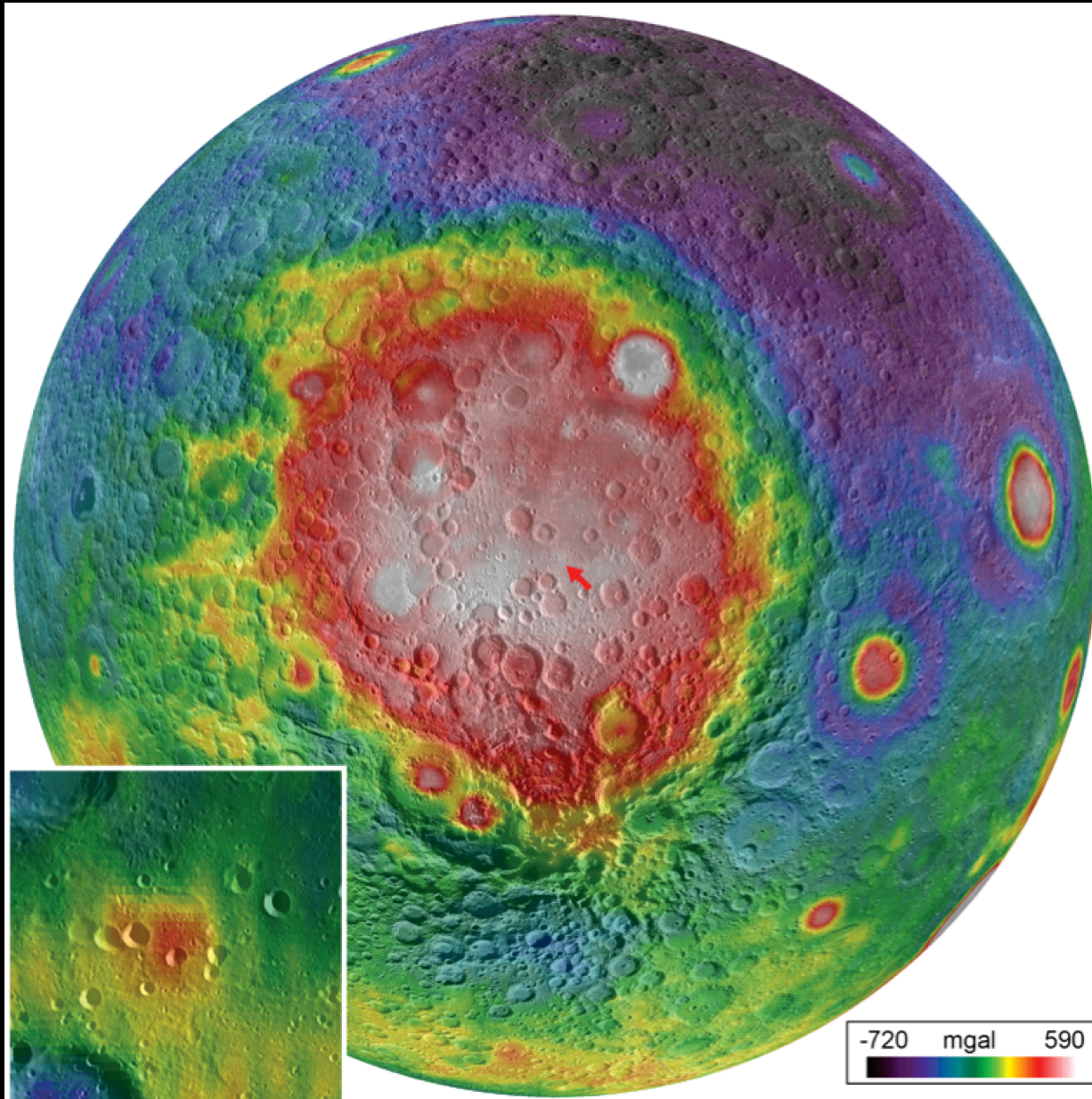
50 km

LOLA / WAC

-15 km -7.5 km



MAFIC MOUND: LOCALIZED BOUGUER ANOMALY



THE ORIGIN OF MAFIC MOUND

- We have evaluated several common lunar processes for their role in the formation of Mafic Mound:
 - Basalt-filled impact crater
 - Impact uplift
 - Impact melting
 - Magmatic construction

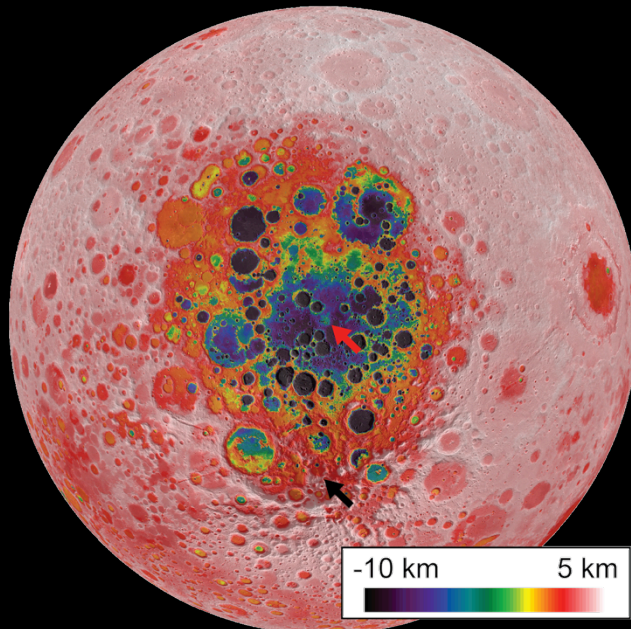
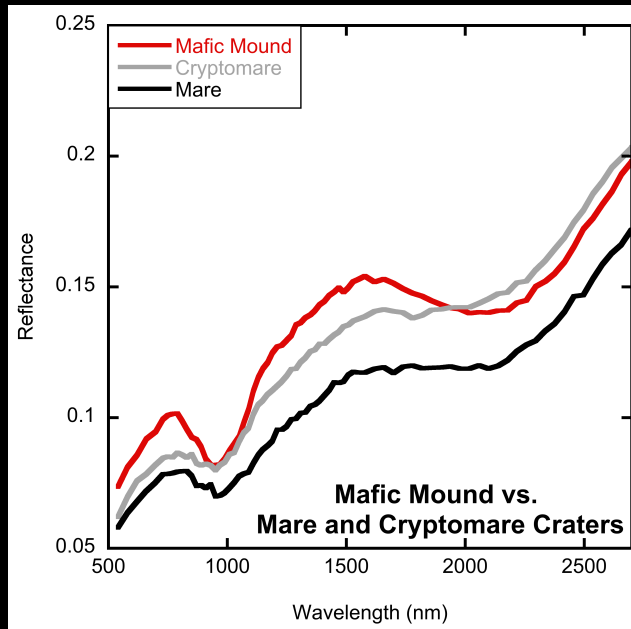
THE ORIGIN OF MAFIC MOUND

- We have evaluated several common lunar processes for their role in the formation of Mafic Mound:
 - ~~Basalt-filled impact crater~~
 - Impact uplift
 - Impact melting
 - Magmatic construction
- The positive topography, homogeneous HCP-bearing composition, and localized Bouguer anomaly are consistent with a magmatic construction.

FORMATION OF LUNAR VOLCANIC EDIFICES

- Typical lunar eruptions involve low viscosities and high effusion rates, leading to large expanses of smooth, flat mare basalts.
- Formation of magmatic constructs requires higher viscosities and lower effusion rates. This can result from:
 - Lower magma temperatures
 - Shallow magma chambers
 - More silicic magma compositions
- What specific processes led to the formation of Mafic Mound?

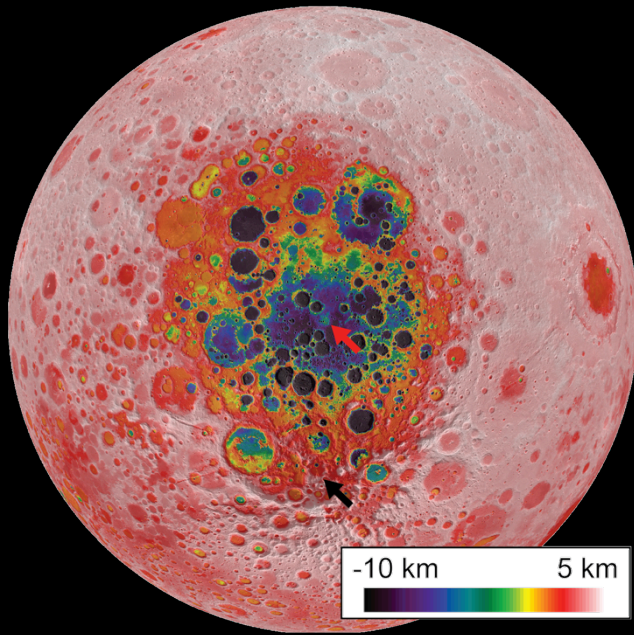
OBSERVATIONAL CONSTRAINTS ON FORMATION



- Mafic Mound exhibits similar pyroxene composition to mare basalts.
- Consistent brightness differences between Mafic Mound and mare basalts implies a different mineral assemblage.
- Mafic Mound's location at the center of SPA suggests a relationship between the features.

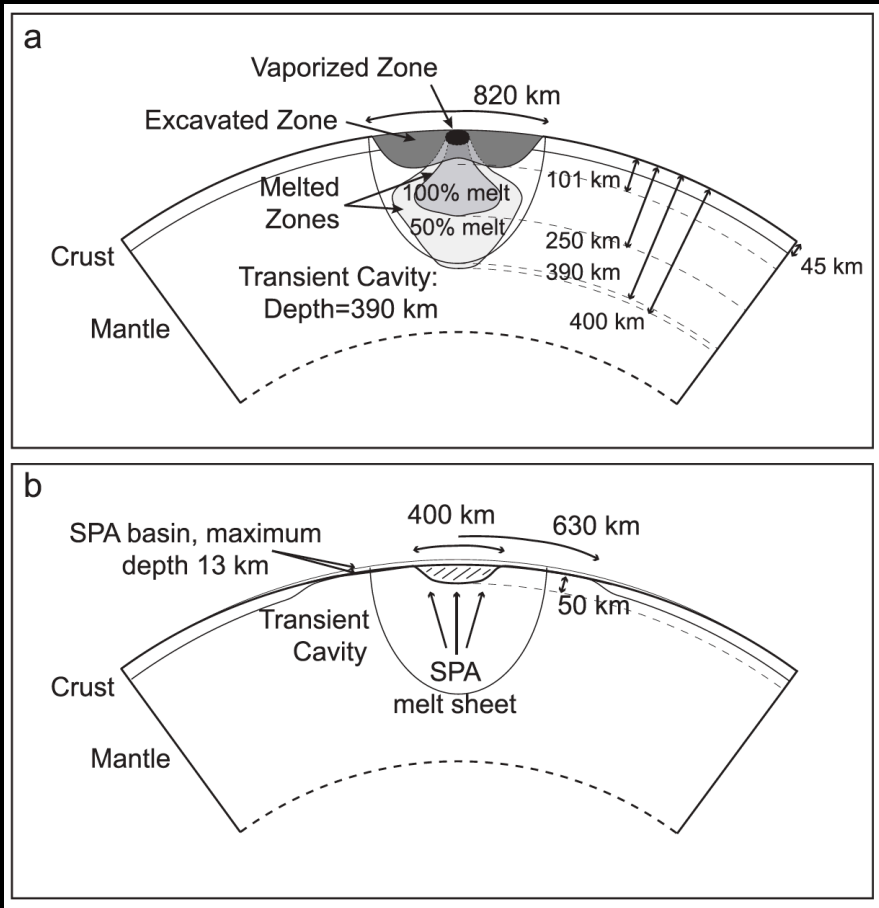
A HYBRID ORIGIN FOR MAFIC MOUND

- We propose that Mafic Mound is a magmatic construct directly related to the formation and evolution of SPA.



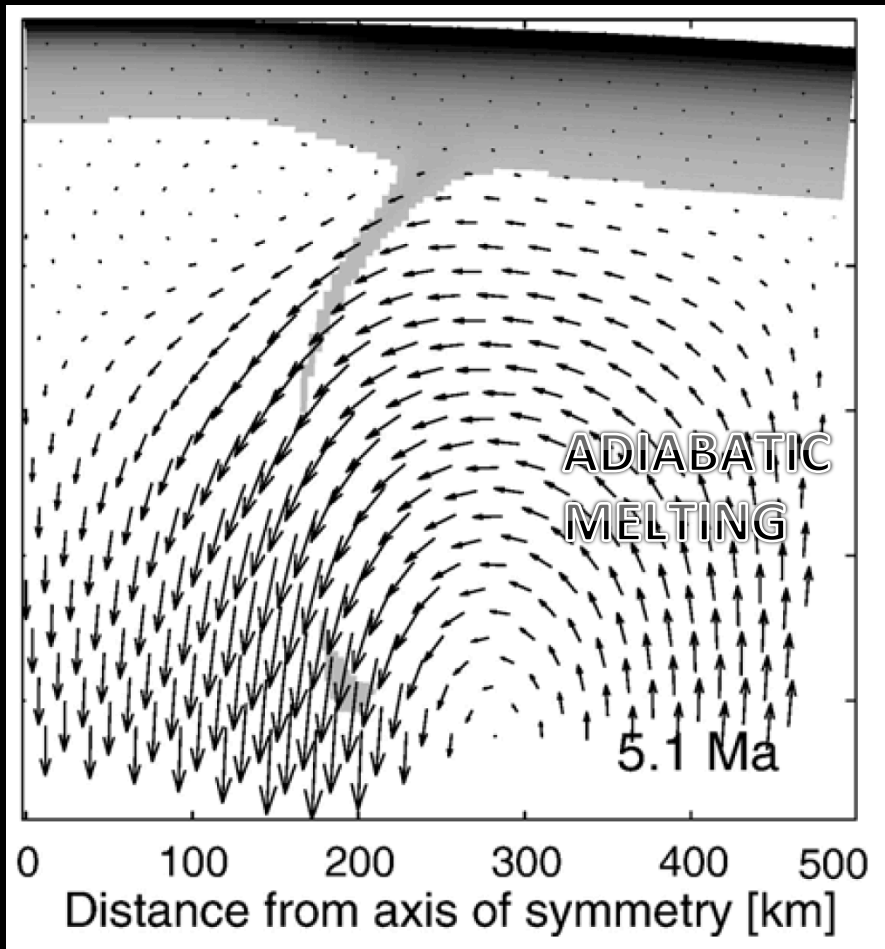
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 - Impact melt [*Hurwitz and Kring, 2014*]



A HYBRID ORIGIN FOR MAFIC MOUND

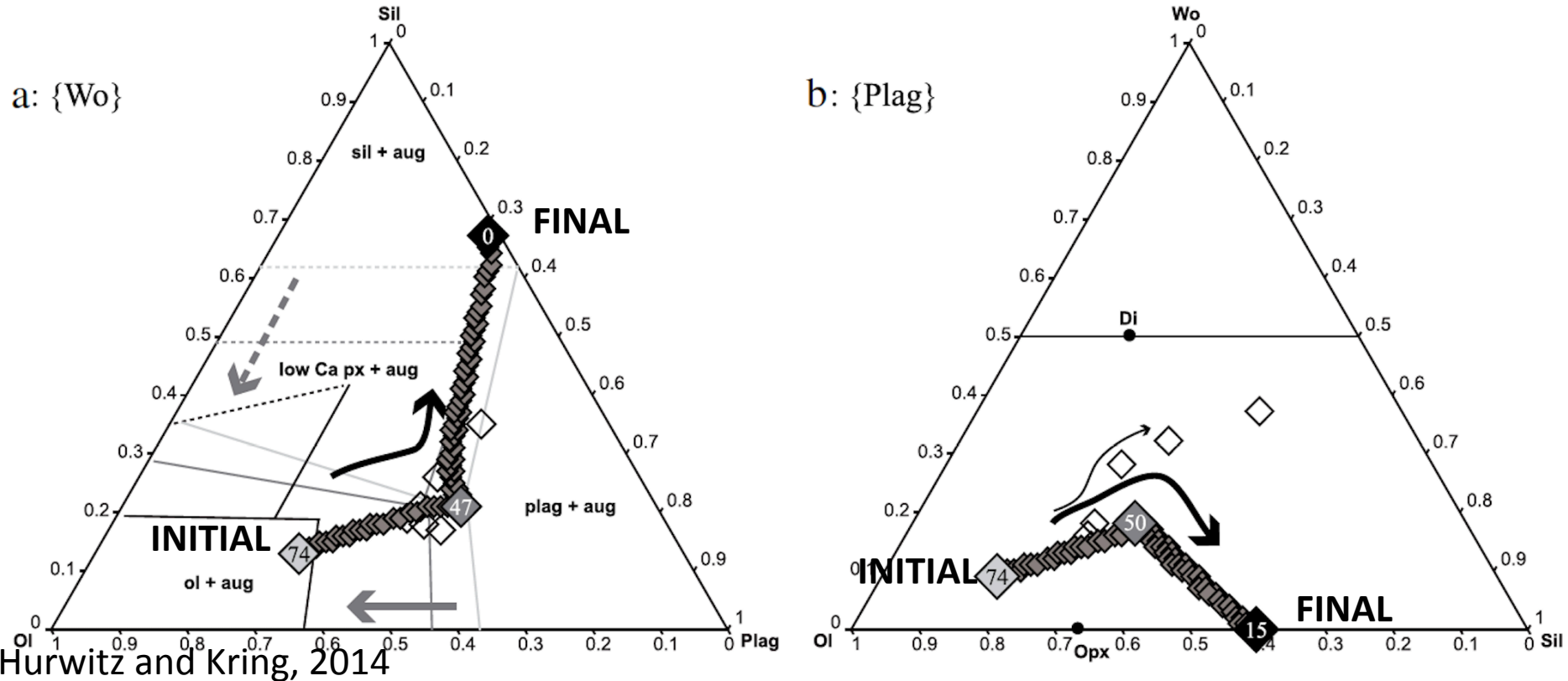
- We propose that Mafic Mound is a magmatic construct directly related to the formation and evolution of SPA.
 - Impact melt [*Hurwitz and Kring, 2014*]
 - Mantle melts from impact-induced decompression and/or convection [e.g. *Elkins-Tanton and Hagar, 2005*]



SUMMARY AND CONCLUSIONS

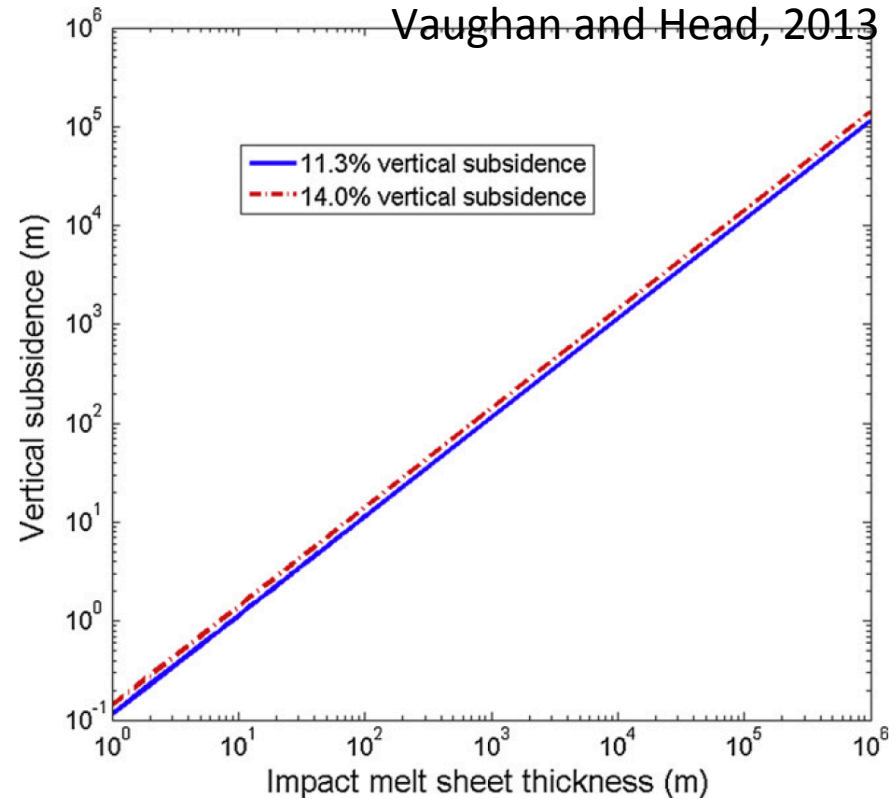
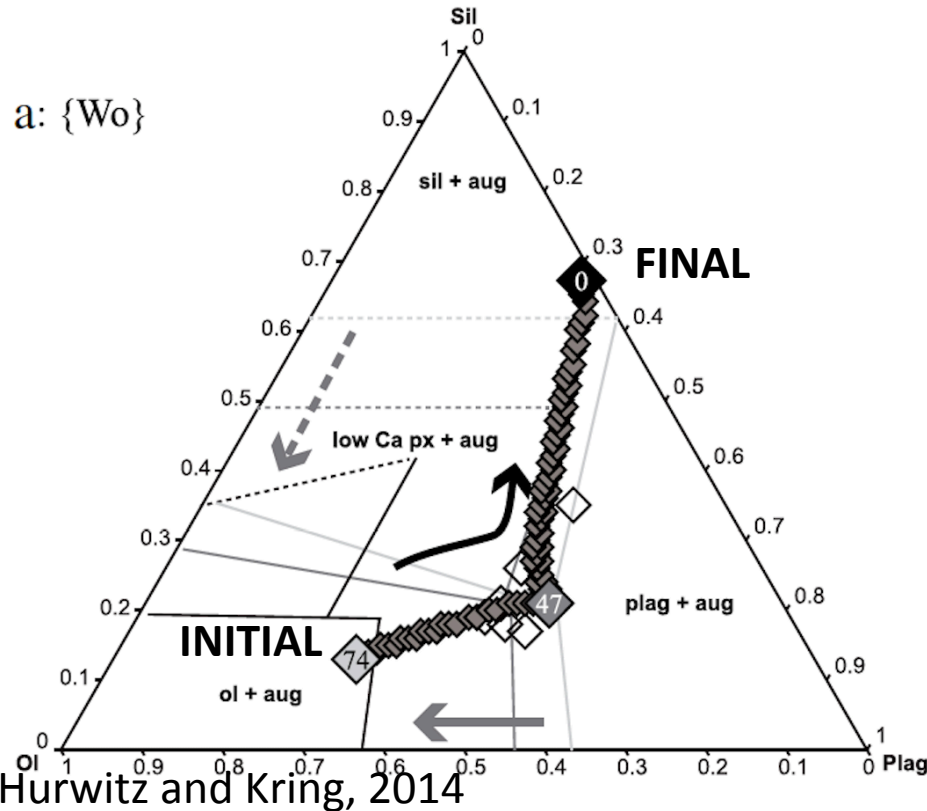
- Mafic Mound exhibits several unique properties:
 - ~75 km feature elevated by ~1 km
 - Homogeneous, Plag+HCP-bearing composition
 - Positive, localized Bouguer anomaly
- A constructive magmatic origin appears to be most consistent with these observations.
- The magma source is directly related to the formation and evolution of SPA.
- Mafic Mound is the manifestation of previously-undocumented lunar magmatic processes.

SCENARIO I: ERUPTED IMPACT MELT



- Models suggest the initial bulk SPA impact melt is an approximately equal ratio of HCP, LCP, and plagioclase
- As the melt evolves, the composition of the liquid approaches a similar composition to Mafic Mound

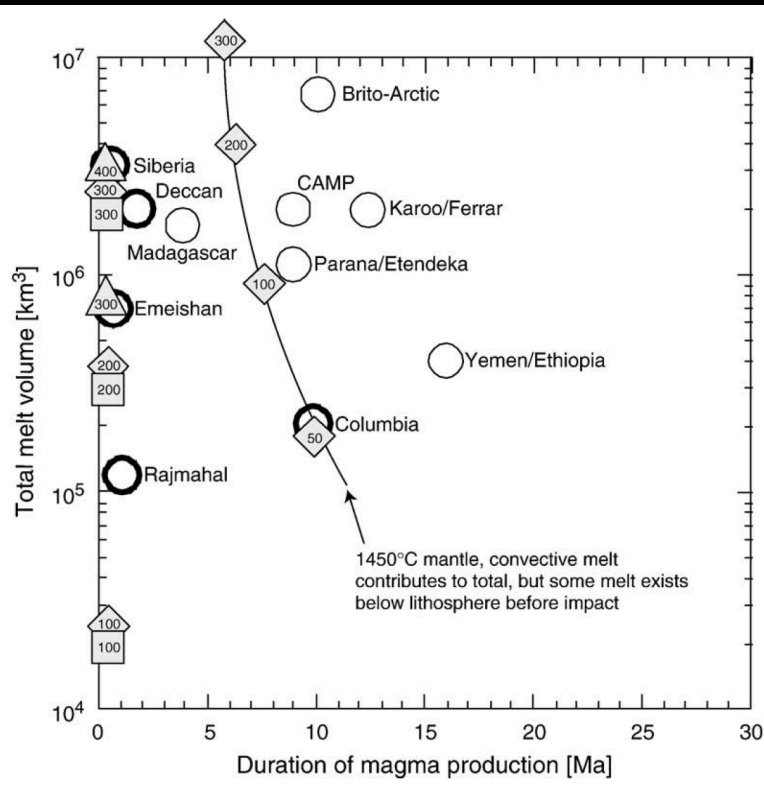
SCENARIO I: ERUPTED IMPACT MELT



- Significant volume changes are expected during the cooling of the melt sheet.
- These volume changes may cause some partially-evolved impact melt to erupt.
- Would a cap of quenched melt support Mafic Mound?

SCENARIO II: INDIRECT IMPACT-RELATED MELTS

- In addition to impact melts, basin formation can cause melting due to:
 - Decompression (related to excavation)
 - Convection induced by isostatic adjustment
- Would form partial melts of the mantle.
 - Compositionally different from mare basalts due to different pressure/depth and extent of melting



Elkins-Tanton and Hagar, 2005